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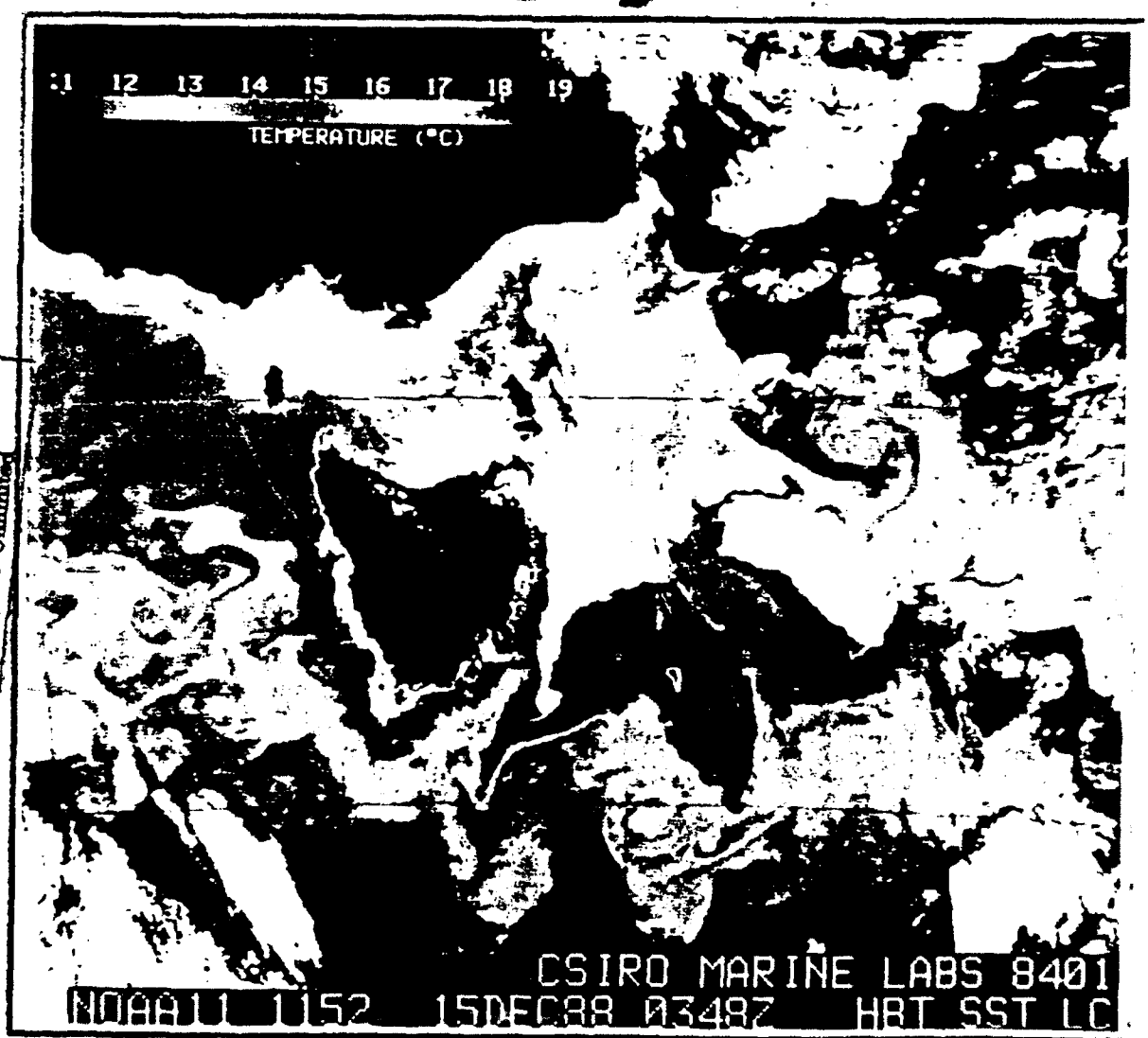

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THE NAVAL RESEARCH LABORATORY REANALYSIS PROJECT

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1. INTRODUCTION

Reanalysis projects have been proposed and are being aggressively pursued at several major numerical weather prediction centers, the most prominent being at the US National Weather Service (NMC) and the European Centre for Medium Range Weather Forecasts (ECMWF) (Kalnay and Jenne 1991). The Naval Research Laboratory (NRL), Marine Meteorology Division, and the Navy's Fleet Numerical Oceanography Center (FNOC), both in Monterey, California, are also planning a reanalysis project that has some similarities to the NMC and ECMWF efforts, but will have some unique aspects as well. Each center has its own motivations for mounting these very ambitious projects, but there are also several common motivations. These include: (1) An extended period of data assimilation such as a reanalysis is an excellent way to test and validate an operational system in a controlled environment without the pressure of operational schedules. (2) Because the reanalysis is done with a 'frozen' version of the data assimilation system, the resulting time series of analyses is homogeneous, without the inevitable discontinuities that occur with constantly changing real-time operational systems. This is particularity important for ocean models, which are very sensitive to atmospheric surface forcing and can produce misleading results if this forcing is abruptly changed because of atmospheric model changes. (3) A homogeneous time series of atmosphere analyses offers the best hope of detecting and predicting global warming and climate change.

The plans for the Navy reanalysis projects differs is some important ways from the NMC and ECMWF projects. Instead of the quite long analysis periods being proposed by NMC and ECMWF (over 30 years in NMC's case), the four year period from 1985 through 1988 has been selected for reanalysis by NRL and FNOC. This is a long enough period to produce useful ocean model surface forcing fields, a critical requirement for Navy ocean model research. However, the period is short enough to allow multiple reruns of the reanalysis with different configurations of the Navy Global Atmospheric Prediction System (NOGAPS). Not coincidently, the reanalysis will be conducted during the first year after a major computer upgrade at FNOC, so ample computer time will be available, and there will be a major effort to upgrade NOGAPS for the new computer system. Multiple reruns of the reanalysis can be an important vehicle for evaluating NOGAPS improvements.

2. THE NOGAPS DATA ASSIMILATION SYSTEM

The Navy reanalysis will be done using an advanced version of NOGAPS now being tested on the new FNOC computer system. NOGAPS has much in common with the other large global numerical weather prediction systems run by the major meteorological centers around the world. An 'update cycle' consists of: (1) data quality control, (2) objective analysis, (3) initialization, and (4) data assimilation forecast. The NOGAPS objective quality control (QC) is described by Baker (1992). The NOGAPS multivariate optimum interpolation analysis is described by Barker (1992) and Goerss and Phoebus (1992). The NOGAPS non-linear normal mode initialization is described by Hogan, et al. (1991). The NOGAPS spectral forecast model is described by Hogan and Rosmond (1991) and Rosmond (1992).

The current operational NOGAPS runs with 79 wave triangular truncation (T79) and 18 vertical levels. The first four year reanalysis sequence will probably be run with this resolution. This will be a shakedown of the system on the new computer and will provide a control data base of analyses to compare to original operational FNOC analyses produced during 1985-1988, and also to subsequent higher resolution reanalyses. The new FNOC computer system will allow substantially greater forecast model resolution, perhaps as high as T150, 30 levels. Our most optimistic scenario is that we will be able to run a reanalysis sequence with NOGAPS resolution in this range. There is considerable uncertainty about global model performance and behavior at these resolutions, however, so a more modest NOGAPS resolution goal somewhere between the current T79 and this upper limit is more likely.

3. IMPLICATIONS FOR TOGA-COARE

The interactions of the atmospheric general circulation, tropical disturbances, and ocean Kelvin waves present great challenges for atmosphere and ocean modeling studies. High quality analysis products of air-sea interface parameters are essential for progress in understanding these interactions. The reanalyses being proposed here and elsewhere are our best source of these products. This is particularly true for interactions where transient forcing of the ocean by the atmosphere is important, such as tropical cyclones in the western pacific both north and south of the equator. A unique aspect of the NOGAPS data assimilation system is that automated tropical cyclone bogusing is an integral part of the update cycle operations. This has been so successful that NOGAPS predicted tropical cyclone tracks in the western Pacific and Indian Ocean have been superior to all other guidance used by the Joint Typhoon Warning Center (JTWC) in Guam for their operational forecasts (Fiorino et al. 1991). Also, perhaps because of the tropical cyclones, NOGAPS has demonstrated excellent ability to capture the episodes of westerly wind bursts in the tropical equatorial Pacific (Phoebus and Kindle 1992). These transient strong westerlies along the equator have been linked to the generation of easterly propagating Kelvin waves in the Pacific (Giese and Harrison 1990). Because of these successes, special emphasis on tropical Pacific phenomena will be part of the design of the Navy reanalysis project.

4. SUMMARY

To the research community at large each of these reanalysis projects will yield numerous benefits. Each of the operational centers will directly benefit from conducting its reanalysis, and also indirectly by having the reanalysis outputs used by a large number of scientists. The Navy effort, with its emphasis on the tropics and atmosphere/ocean interaction, will contribute a data base particularly well suited for research in these areas.

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